Biodiversity in Wallonia

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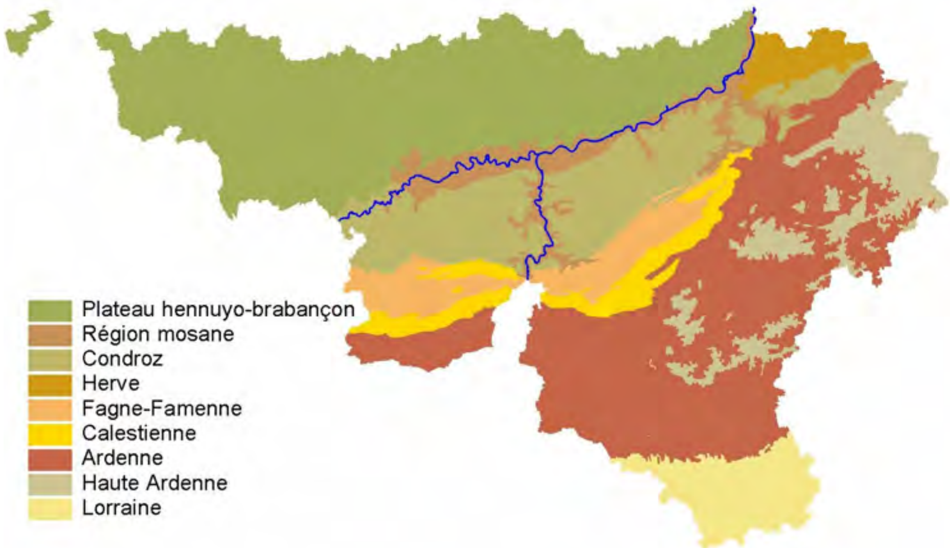
1. GENERAL OVERVIEW

Wallonia occupies a privileged position in Europe. It is not only located at the crossroads of the Atlantic and Continental regions, but also exposed locally to Boreal and sub-Mediterranean influences. This specific location and the existence of a marked topographical, climatic and geological gradient are at the origin of a great diversity of habitats and species over a very small territory (16,844 km^2). The diversity of abiotic conditions, together with the variety of past and present land use practices, make up the driving forces explaining current biodiversity.

Nine biogeographical regions can be defined in Wallonia on the basis of landscape, climatic and soil conditions (see figure 1 and table 1). Each of them is characterised by specific land use practices and habitats. The 'hennuyo-brabançon' plateau corresponds to the area situated north of the Sambre and Meuse valleys. As its soil is made of a deep loamy and fertile layer, it is intensively used for agriculture and very few forests and extensive areas remain on this plateau. The southern part of the region is much more diversified and made of eight biogeographical areas. The soils are often shallow and contain different kinds of sedimentary rocks according to the region (e.g. limestone, sandstone and shale). The forest cover is still important as these areas are not suitable for intensive land use.



1
The main biogeographical regions in Wallonia (based on data from the Research Centre for Nature, Forests and Wood).

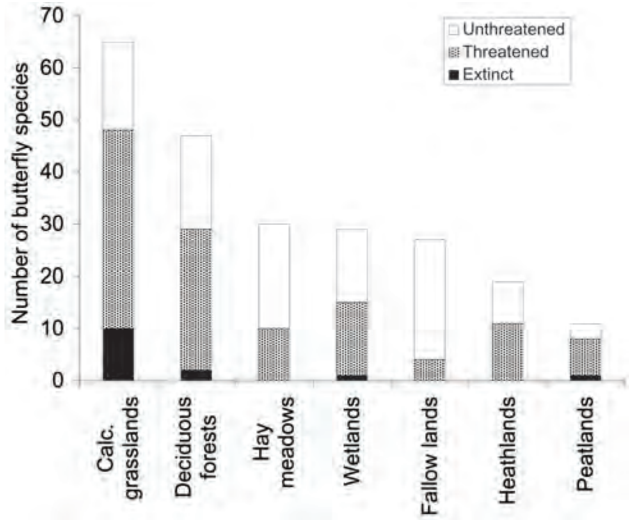
Table 1. Presentation of the main natural regions in Wallonia.

Natural region	Bedrock	Land use	Typical forest type	Peculiarities
Plateau hennuyo-brabançon	loam and sand	intensive crops	*Fago-Quercetum*	-
Région mosane	limestone, schist, sandstone and gravel	forests and meadows	-	cliffs, calcareous grasslands and slope forests (*Acerion*)
Condroz	sandstone and limestone	crops, meadows and forests	*Primulo-Carpinetum*	parklands and overmature trees, hay meadows, calacareous grasslands
Pays de Herve	chalk, limestone, schist	meadows and crops	-	orchards, hedgerows
Fagne-Famenne	schist (and limestone)	forest and meadows	*Stellario-Carpinetum*	hay meadows, heathlands
Calestienne	limestone	crops, meadows and forests	*Carici-Fagetum*	calcareous grasslands, slope forests
Ardenne	schist and sandstone	forests and meadows	*Luzulo-Fagetum*	wet grasslands and heathlands, slope forests
Haute-Ardenne	schist and shale	forests and meadows	*Vaccinio-Betuletum*	peat-lands, heathlands, wet grasslands and hay meadows
Lorraine	sand, sandstone and limestone	crops, meadows and forests	*Melico-Fagetum*	hay meadows, heathlands, peatlands, hedgerows, calcareous grasslands

2. Historical evolution of the landscapes in Wallonia

Before the rise of human populations in Western Europe, natural landscapes were dominated by oak and beech forest ecosystems where a very rich biodiversity was to be found. Because of the development of agriculture and the exploitation of woody resources, such forests were progressively transformed, cleared and fragmented. As a result, pristine and natural forests are currently reduced to very small areas in Europe. As the naturalness of forest ecosystems decreased, some woodland inhabitants disappeared from our country. Auroch (*Bos taurus*), European bison (*Bison bonasus*), brown bear (*Ursus arctos*), capercaillie (*Tetra urogallus*), elk (*Cervus elaphus*) and lynx (*Lynx lynx*) are famous examples of animals that lived previously in our forest ecosystems. Numerous small-sized species of plants and insects linked to old-growth forests and damp microclimate underwent the same fate, for instance those species depending on overmature trees and large amounts of dead wood.

Though they had a negative impact on true woodland species, ancient silvo-pastoral practices also created interesting habitats for wildlife. Traditional management such as coppicing, pollarding, slash and burn practices, sod cutting, grazing, mowing, reed cutting, etc. favoured landscape openness and the formation of specific habitats such as extensive grasslands, heaths, peatlands, reed beds, hay meadows, hedgerows, orchards, coppice and pasture woodlands. Such habitats have been widely represented all over Wallonia during previous centuries, especially on stony and wet soils of the Fagne-Famenne, Calestienne, Ardenne and Lorraine regions. They sheltered very diversified plant and animal communities that formed a substantial part of the Walloon biodiversity. Hence, one-third of the Belgian flora is closely linked to heaths, dry grasslands and hay meadows (STIEPERAERE & FRANSEN 1982). Numerous threatened butterfly species are also found in the same types of habitats (figure 2). As they have favoured habitat diversification and species richness at the landscape level, traditional practices are part of our bio-cultural heritage and deserve to be carried on in the framework of a strategy for nature conservation.



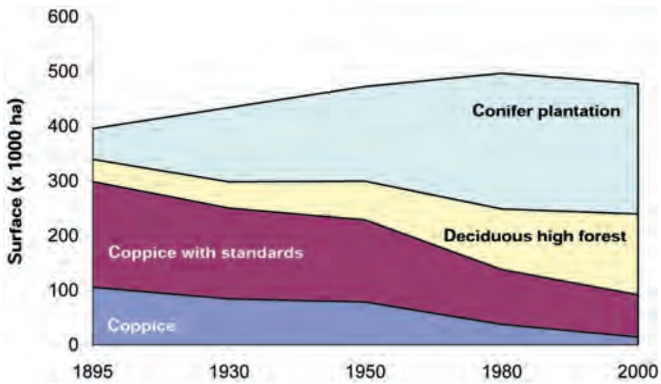
2
Habitat and status of butterflies in Wallonia (based on GOFFART & DE BAST 2000).

Traditional villages usually included small farms with enclosed gardens and orchards surrounded by arable fields fertilised with manure produced by cattle and horse. These animals used to graze in coppice woodlands or forests. In many areas, herbs and grasses were cut after coppicing and the upper part of the litter was stripped and burned when dried out. The coppiced area was used for cereal production during 1 or 2 years. Thereafter, broom (*Cytisus scoparius*) sown or developing from the soil seed bank, was used as fodder for sheep or as litter. Wet meadows, situated along streams and rivers, mires, wet heaths and fens were mown for winter fodder or litter. Animals usually grazed under the lead of herdsmen or shepherds and were taken back to the village every evening for milking and, especially, manure harvesting (DELESCAILLE 2002).

Crowded flocks of sheep and goat exerted a major grazing pressure on wooded landscapes and transformed them in open habitats such as heaths and moors on acidic soils and calcareous grasslands on limestone. In 1850, the number of sheep exceeded 150,000 in the Ardenne, with pastoral landscapes covering about 130,000 ha (NOIRFALISE 1989).

The surface of extensive landscapes has begun to decrease in Belgium since the 1847 law on commons improvement in a context of timber shortage and increasing international trading of food and wool. Since then, extensive grazing has progressively been abandoned and cattle and horses have been driven away from woodlands. Heathlands, peatlands and calcareous grasslands were considered as 'unproductive' areas and were afforested with pines and Norway spruce or transformed into permanent pastures and cereal fields. At the end of World War II, land reclamation speeded up with the use of new agricultural techniques and tools such as chemical fertilisers, ensilage and imported protein food for livestock (LAMBERT *et al*. 2000, DELESCAILLE 2002).

As a result, more than 90% of the landscapes produced by traditional management practices have been lost during the last century. At the same time, the total forest area increased by 20% while woodland structure and composition changed significantly. Coppice surfaces



3
Evolution of the forest stand structure in Wallonia during the 20th century (based on GÉRARD & LAURENT 1995 and LECOMTE *et al.* 2003).

were progressively abandoned and transformed into conifer plantations for timber production (figure 3) (GÉRARD & LAURENT 1995).

These trends can be illustrated by two studies on landscape evolution: the Tailles Plateau in the Ardenne and the Viroin Valley in the Calestienne. On the Tailles Plateau, peat- and heathlands occupied more than 50% of the total area around 1770. Two centuries later, most have been improved or reclaimed for permanent pastures or spruce plantations whereas relict peat- and heathland cover today less than 1% of the same area. The cover of broad-leaved forest also decreased considerably following the transformation of old coppice into conifer plantations (table 2) (DUMONT 1975).

Table 2. Evolution of landscape units in Ardenne (Tailles plateau) between 1770 and 1970. The trend refers to a surface ratio onto the 1770 situation (after DUMONT 1975).

	1770		1970		Trend
	Area (ha)	% of tot. area	Area (ha)	% of tot. area	
Broad-leaved forests	14,500	25%	6,500	11%	– 55%
Coniferous plantations	0	0%	25,100	43%	+ + +
Heaths and moors	28,600	49%	100	0.2%	– 99%
Bogs	950	2%	500	1%	– 47%
Peat-lands and wet grasslands	5,400	9%	100	0.2%	– 98%
Urban and intensive agricultural areas	8,550	15%	25,900	45%	+ 203%

The evolution of the limestone landscape displays similar trends. Calcareous grasslands that were largely distributed on stony soils of Devonian and Carboniferous limestone (Viroin, Meuse, Lesse and Ourthe valleys) vanished from most areas because of scrub colonisation or pine plantation; 92% of the calcareous grasslands of the Viroin valley have disappeared since 1770 (table 3). Current grassland relicts are strongly isolated and impoverished (LEDUC 2002).

In summary, the evolution of land use practices in Wallonia have led to the progressive closure of the landscape, the increase in standing wood resources and the intensification of remaining agricultural areas.

Table 3. Evolution of the surface (ha) of landscape units in the Viroin valley (Calestienne) between 1770 and 2002. The trend refers to a surface ratio in comparison with the 1770 situation (after Leduc 2002).

	1770	1870	1964	2002	Trend
Forests	288	712	750	1,607	+ 458%
Fallows and calcareous grasslands	611	477	716	51	– 92%
Crops	2,205	1,885	855	766	– 65%
Intensive grasslands	389	357	1,072	951	+ 144%
Urban areas	55	82	127	155	+ 182%

3. Biodiversity and current status of some habitats in Wallonia

3.1. Semi-natural open habitats

Semi-natural open habitats are characterised by specific and diversified plant communities that often produce mass flowering. They provide interesting resources exploited by plenty of specialised anthophilous and phytophagous insects. Heathlands as well as dry and humid grasslands are key habitats for numerous insects species (e.g. Orthoptera, Hemiptera, Lepidoptera and Hymenoptera). They are also often visited by specific and threatened reptiles and birds. For instance, the remaining population of black grouse (*Tetrao tetrix*) is strictly dependent on large areas of heathlands while whinchats (*Saxicola rubetra*) and corn crakes (*Crex crex*) are mostly found in hay meadows. Two lizard species (*Podarcis muralis* and *Lacerta agilis*) and the smooth snake (*Coronella austriaca*) are typically found in dry grasslands and heathland ecosystems.

Some open habitats have developed under drastic azonal climatic conditions. Bogs of the Hautes-Fagnes Plateau are under the influence of Boreal and mountain climates characterised by cold winters and large amounts of precipitations. Nordic vegetation and fauna are found in these bogs such as, for instance, several species of Boreal dragonflies: the northern damselfly *Coenagrion hastulatum*, subarctic darner *Aeshna subarctica*, northern emerald *Somatochlora arctica* and nordic marsh dragonfly *Leucorrhinia rubicunda*. On the other hand, sub-Mediterranean species (e.g. grasshoppers and cicadas) typically live in dry grasslands found on south-facing rocky slopes of the Calestienne, Fagne-Famenne and Lorraine.

As described previously, most of the open areas resulting from traditional management drastically decreased during the 19^{th} and 20^{th} centuries. Relicts are still present and are sometimes included into protected areas. Nowadays, calcareous grasslands are mostly represented in the Calestienne and Condroz, hay meadows in Fagne-Famenne and Lorraine, and humid meadows, heathlands and peatlands in Ardenne.

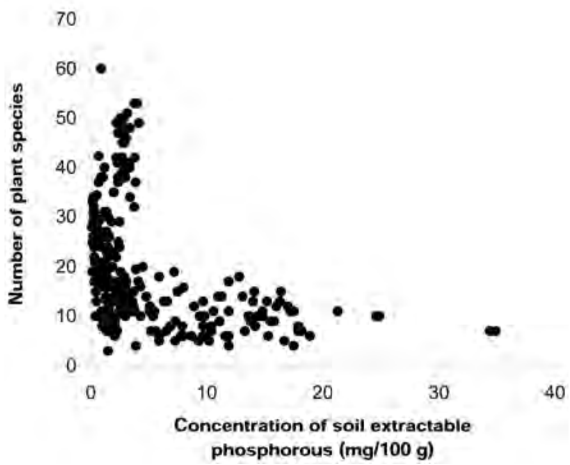
Detailed data about the exact area of such habitats are very difficult to obtain as no systematic habitat survey has been performed so far in Wallonia. Crude estimations of areas included into the Natura 2000 network give however a first idea about the current extent of open semi-natural habitats, providing that the global quality of the site is good (A in table 4). Based on these values, one may estimate that more than 2,000 ha of heaths, 1,300 ha of various types of dry grasslands, 1,200 ha of tall-herb humid meadows, 1,000 ha of hay meadows and 200 ha of bogs are still present in Wallonia. These values need to be confirmed after a detailed mapping of each of the Natura 2000 sites (currently in progress).

Table 4. Main open habitat types included into the Natura 2000 network in Wallonia and the global biological quality and estimated area for each of them. Priority habitat types are marked with (*) (based on data from the Research Centre for Nature, Forests and Wood).

Code	Habitat types	Global quality		Total area
		A	B + C	
	Inland dunes			
2310	Dry sand heaths with *Calluna* and *Genista*	60%	40%	530 ha
2330	Inland dunes with open *Corynephorus* and *Agrostis* grasslands	95%	5%	40 ha
	Temperate heath and scrub			
4010	Northern Atlantic wet heaths with *Erica tetralix*	40%	60%	2,090 ha
4030	European dry heaths	45%	55%	1,980 ha
	Sub-mediterranean and temperate scrub			
5110	Stable xerothermophilous formations with *Buxus sempervirens* on rock slopes	70%	30%	400 ha
5130	*Juniperus communis* formations on heaths or calcareous grasslands	55%	45%	30 ha
	Natural grasslands			
6110 (*)	Rupicolous calcareous or basophilic grasslands of the *Alysso-Sedion albi*	60%	40%	170 ha
6130	Calaminarian grasslands of the *Violetalia calaminariae*	20%	80%	50 ha
	Semi-natural dry grasslands			
6210 (*)	Semi-natural dry grasslands and scrubland facies on calcareous substrates	35%	65%	1,060 ha
6230 (*)	Species-rich *Nardus* grasslands, on siliceous substrates in submountain areas	80%	20%	990 ha
	Semi-natural tall-herb humid grasslands			
6410	*Molinia* meadows on calcareous, peaty or clayey- silt- laden soils	30%	70%	2,300 ha
6430	Hydrophilous tall herb fringe communities	10%	90%	5,390 ha
	Mesophile grasslands			
6510	Lowland hay meadows (*Alopecurus pratensis*, *Sanguisorba officinalis*)	10%	90%	6,680 ha
6520	Mountain hay meadows	30%	70%	1,360 ha
	Sphagnum acid bogs			
7110 (*)	Active raised bogs	55%	45%	240 ha
7120	Degraded raised bogs still capable of natural regeneration	40%	60%	1,600 ha
7140	Transition mires and quaking bogs	50%	50%	110 ha
	Calcareous fens			
7230	Alkaline fens	20%	80%	120 ha

A large number of sites have a lower global quality (categories B and C), reflecting either their small surface or their low phytocoenotic integrity (alteration of plant communities); they should deserve to be restored as soon as possible through adequate management and conservation practices. Bad site qualities can be explained through the following threats: eutrophication and water pollution (habitat codes as referred to in table 4: 6410, 6430, 6510, 6520), fertilisation, early mowing and intensive grazing (6230, 6410, 6430, 6510, 6520), acid rain (6210), drainage (6410, 6430, 7110, 7120, 7140), conifer plantations (most habitat types), natural colonisation by trees and scrub (most habitat types), invasion by alien species (6410, 6430).

Richness decrease of plant communities in old permanent grasslands of Western Europe is illustrative of the impact of the intensification of agricultural practices on biodiversity. Grasslands that formerly sheltered as much as 120 plant species are today strongly impoverished due to early mowing and NPK fertilisation. Phosphorous is particularly detrimental to biodiversity as a high concentration of this element in the soil reduces plant species richness to less than 20 species (figure 4). Restoration of the typical diversified vegetation of such grasslands is a very long and exacting process as phosphorous forms stable and persistent stocks in the soil and is weakly exported in forages (Janssens *et al.* 1998).



4
Impact of the concentration of soil extractable phosphorus on plant species richness in old permanent grasslands from Western Europe (based on Janssens *et al.* 1998).

In a nutshell, it can be said that semi-natural open habitats are threatened by air and water pollution, land reclamation practices and the cessation of traditional management. Often, restoration based on traditional practices will deserve to be adapted to the conservation of rare and sensitive species. Mowing, for example, has to be delayed or applied each year only to a part of the site (rotational management) to allow specific invertebrate species to survive (Delescaille *et al.* 1990, Goffart *et al.* 2001).

3.2. Forest ecosystems

Forest areas cover about 475,000 ha, i.e. one third of the Walloon territory. Half of the forest cover is made of semi-natural deciduous woodlands. The other part includes plantations of exotic species, mainly conifer trees (Lecomte *et al.* 2003). Thanks to the high geomorphological diversity of the territory, a wide range of different forest types is found (Noirfalise 1984), including three priority forest types and seven other forest types of the Habitats Directive (table 5).

The quality of forest biodiversity in Wallonia is hereafter evaluated in three successive steps: (1) the biological value or biodiversity potential in each forest type, (2) the conservation value, i.e. forest landscapes as key habitats for red list species and (3) the natural value or naturalness, i.e. the relative proximity of forests to the structure of pristine ecosystems and their natural dynamics.

(a)

(b)

(c)

(d)

(e)

(f)

Plate 1

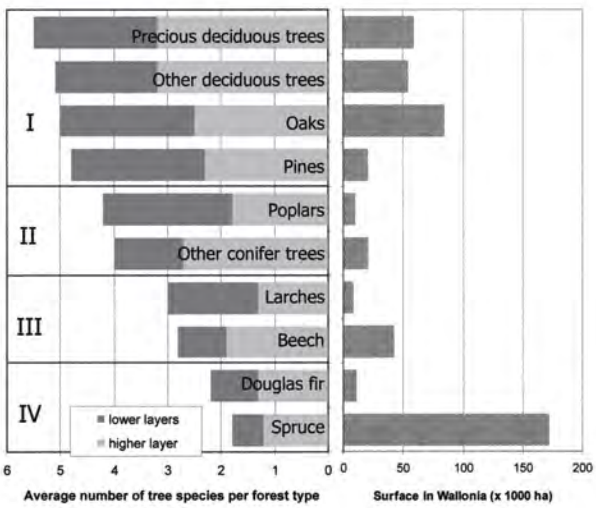
(a) Old-growth beech forest of the Brandehaag (Hertogenwald). Overmature tree and dead wood are two key components for forest biodiversity. Both are unfortunately poorly represented in Walloon woodlands (photograph by F. HIDVEGI).
(b) As a major cause of the reduction of forest areas, grazing had a major impact on landscape structure up to World War II. It created valuable habitats for biodiversity such as heathlands and extensive grasslands. Grazing management is still used today to restore such habitats for conservation purposes (see pictures c and d) (photograph by J.-L. GATHOYE).
(c) Because of the decline of sheep breeding and large-scale reforestation, heathland surfaces decreased drastically during the two last centuries. Remnants are currently represented into military areas and in small forest gaps (photograph by J.-L. GATHOYE).
(d) Calcareous grasslands are also the legacy of past traditional grazing practices. They form one of the most species-rich terrestrial ecosystems in Western Europe and are included into the priority habitats of the EU Habitats Directive (photograph by J.-L. GATHOYE).
(e) Bog ecosystems are mainly represented in Haute-Ardenne and host specific Boreal and Alpine species assemblages (photograph by Ph. GOFFART).
(f) Freshwater biodiversity hotspots are mainly located in the Ardenne, especially in areas with a high forest cover and low human population density (e.g. Lesse, Ourthe and Semois basins). These hotspots host rare flagship species such as the pearl mussel (*Margaritifera margaritifera*) and otter (*Lutra lutra*) (photograph by J.-L. GATHOYE).

Table 5. Forest types included into the Natura 2000 network in Wallonia and estimated area for each of them. Priority habitat types are marked with (*) (based on data from the Research Centre for Nature, Forests and Wood).

Code	Forest type	Estimated area (ha)
	Beech forests	
9110	*Luzulo-Fagetum* beech forests	39,910
9120	Atlantic acidophilous beech forests	2,710
9130	*Asperulo-Fagetum* beech forests	11,660
9150	Medio-European limestone beech forests	2,860
	Oak forests	
9160	Oak and oak-hornbeam forests	22,390
9190	Old acidophilous oak woods on sandy plains	1,240
	Other forest types	
9180 (*)	Forests of slopes, screes and ravines	2,890
91D0 (*)	Bog woodland	1,970
91E0 (*)	Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior*	6,700
91F0	Riparian mixed forests	20

3.2.1. Biological value

Stand types recognised across the Permanent Survey of Woody Resources (Lecomte & Laurent 1999) are characterised by contrasting tree species richness. Stands dominated by heliophilous tree species as oak, ash, birch or pine are much more diversified than those made of shade-tolerant trees (figure 5). Data presented elsewhere (Branquart *et al.* 2003) confirm that the former tree species have a larger potential for associated taxa (phytophagous, saproxylic, saprophagous and epiphytic organisms) and have therefore a higher biological value. It should be noted that regardless of tree species, the biodiversity potential of trees is highly dependent on their age. Stand types characterised by a high biological value and potential for biodiversity cover about 45% of the Walloon forest.



5
Forest stands in Wallonia. Average tree species richness (left) and relative amount of the different stand types (right). Stand types were gathered into 4 groups according to tree species richness in the lower and higher vegetation layers. Precious deciduous trees refer to stand types dominated by *Acer*, *Fraxinus*, *Prunus* and *Ulmus* or by a mixture of oak and beech trees (based on the Permanent Survey of Woody Resources and Lecomte *et al.* 2003).

3.2.2. Conservation value

As detailed in table 6, forest ecosystems provide a habitat for numerous plant and animal species. Considering all groups together, about half of these species are rare or threatened. Current pressures on these organisms are (1) plantation of exotic trees, (2) closure of the forest canopy (steep wood margins, increase of shade-tolerant trees, coppice cessation, scarcity of extensive openings) and (3) rarity of overmature trees and dead wood. Saproxylic organisms are probably the most threatened species, as indicated by the high proportion of endangered species among lichens, hover flies and cavity-nesting bats and birds.

Some examples of recent population increase can however be found among emblematic bird species, as it is the case for the black stork (*Ciconia nigra*), middle-spotted woodpecker (*Dendrocopos medius*) and black woodpecker (*Dryocopus martius*). These species take advantage of the current ageing of high deciduous forests. Unfortunately, the regeneration shortage of broad-leaved trees (LEMAIRE 2001) and the recent decrease in rotation time in most forest types challenge the long term survival of such populations.

Table 6. Richness of forest flora and fauna in Wallonia and proportion of rare and threatened species [after DIEDERICH & SÉRUSIAUX 2000 (1), BRANQUART *et al*. 2003 (2), Anonyme 2003 (3) and SPEIGHT *et al*. 2000 (4)].

Taxonomic group	Number of forest species	Proportion of rare or threatened species	Ref.
Epiphytic lichens	354	73%	1
Indigenous trees	64	27%	2
Ground beetles (Carabidae)	47	23%	3
Butterflies (Rhopalocera)	48	67%	3
Saproxylic hoverflies (Syrphidae)	52	83%	4
Other hoverflies (Syrphidae)	105	50%	4
Birds	77	31%	3
Mammals	42	45%	3

3.2.3. Natural value

Because of the intensive human activity in woodlands since the Neolithic, the naturalness of the Walloon forest is quite low. Overmature trees are very scarce and the mean volume of dead wood (snags and logs) is only about 6.6 m^3/ha (LECOMTE & LAURENT 1999), as compared to volumes over 100 m^3/ha in natural forest ecosystems (VALLAURI *et al*. 2002).

A recent study based on ancient forest plants showed that plots corresponding to original forest conditions and forest continuity (HERMY *et al*. 1999) are mainly located in lower valleys of the Meuse tributaries: Hermeton, Lesse, Ourthe, Semois, Warche, etc. They are typically found on uneven sampling plots (steep slopes) with diverse and fertile soil conditions and high deciduous cover (BRANQUART *et al*. 2003). Some of them should deserve to be designated as strict forest reserves in order to restore natural processes and old growth conditions.

As a conclusion, it can be said that Walloon forests present a very high potential for biodiversity, which is however threatened by modern forest management practices. This potential could be enhanced in the future providing that conservation management practices (e.g. close-to-nature forestry, opening of forest canopy, green tree retention, restoration of degraded habitats) be adopted in woodland ecosystems, together with the creation of a representative network of strict forest reserves.

3.3. Running waters

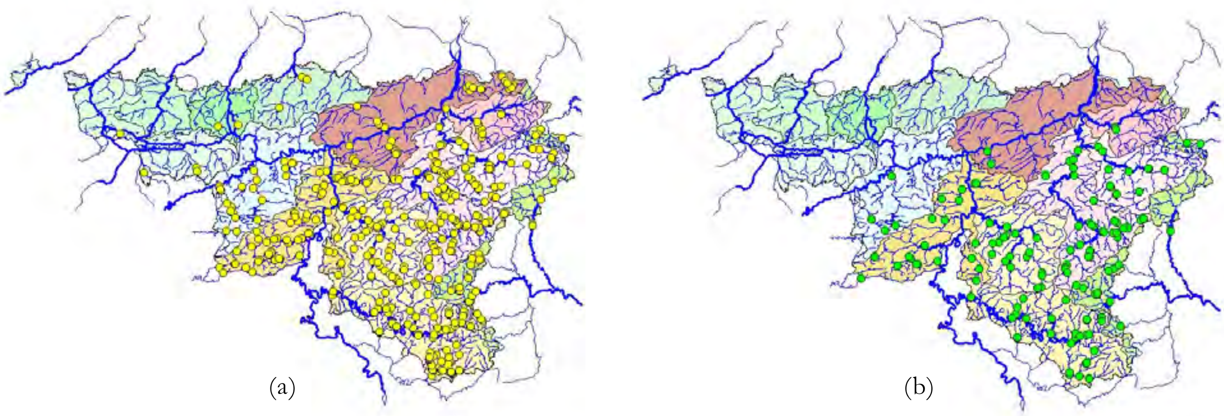
The water quality of waterways and surface waters in Wallonia is controlled by means of several biological, physico-chemical and bacteriological monitoring networks (DE PAUW *et al*. 2001). One of these monitoring programmes uses the biotic index method, which is based on the sampling of benthic macro-invertebrate communities (worms, molluscs, insect larvae, etc.). The biotic index allows the characterisation of both the quality and biodiversity of waterways (IBGN, Norme AFNOR NF T 90-350). The programme has been running since 1997 and concerns 200 waterways in Wallonia that are systematically assessed through 400 collecting sites sampled in a three-yearly cycle.

In addition to the diversity of river substrates, benthic communities are extremely useful to appraise water quality. A non-polluted river exhibits a high faunal diversity and is characterised by invertebrate taxa that are very sensitive to organic pollution and very demanding in oxygen, such as larvae of stoneflies (Plecoptera), caddisflies (Trichoptera) and mayflies (Ephemeroptera). In the presence of pollution, these taxa disappear and biological diversity decreases significantly. Results from the monitoring programme indicate that most of the waterways situated north of the Sambre-Meuse axis present very impoverished invertebrate complexes (biotic index inferior to 8/20). This situation arises from the contamination of surface waters by domestic, agricultural and industrial effluents. On the opposite, running waters in southern Wallonia are usually much less polluted and host more diverse benthic invertebrate communities (biotic index higher than 12/20). They beneficiate from the important forest cover and from a lower urbanisation.

Results obtained from other inventories of pollution-sensitive taxa confirm these tendencies. In this regard, the bullhead (*Cottus gobio*) and brook lamprey (*Lampetra planeri*) are confined to rivers characterised by a high biotic index and a low pollution load (figure 6). This is also the case for the white-throated dipper (*Cinclus cinclus*), otter (*Lutra lutra*) and pearl mussel (*Margaritifera margaritifera*). Unfortunately, populations of the last species do not reproduce any more in Wallonia probably as a consequence of excessive water turbidity and bad river bed conditions (LAUDELOUT & LIBOIS 2003).

The establishment of monitoring networks for aquatic biodiversity (benthic macro-invertebrates, fish, bryophytes, etc.) is too recent to deduce conclusions relating to its long-term evolution. The fragmentary information that can be gathered seems to show some improvement in the aquatic biodiversity of the Meuse and Sambre rivers, and can be linked to a reduction in industrial pollution in these waterways. This pollution decrease is counterbalanced by an increase in domestic effluents, which are responsible for the eutrophication of smaller-sized watercourses such as the Ourthe or the Lesse (PHILIPPART 2000). Moreover, information gathered on dragonflies in Wallonia by GOFFART (2000) shows that species with larvae living in fast running water (e.g. *Oxygastra curtisii, Onychogomphus forcipatus* and *Gomphus vulgatissimus*) are proportionally more threatened than other dragonfly species. They particularly suffer from the deterioration of riverbanks and eutrophication. Riverbank alteration or reclamation has also deleterious effects on the populations of the kingfisher (*Alcedo athis*) and sand martin (*Riparia riparia*) that declined drastically in recent years (LAUDELOUT & LIBOIS 2003).

The Walloon hydrographic network thus presents rather contrasted situations. Streams with good physico-chemical water quality and well-structured riverbanks can nonetheless be found (e.g. Lesse, Ourthe, Rulles, Semois, Sûre et Viroin). They still host very diversified aquatic communities and critically endangered species with specific ecological requirements. They form true 'biodiversity hotspots' that must be protected at all costs.



6
Distribution map of post-1980 observation of (a) the bullhead (*Cottus gobio*) and (b) the river lamprey (*Lampetra planeri*) in Wallonia (based on data from the Research Centre for Nature, Forest and Wood).

4. SPECIES SURVEYS

4.1. Monitoring programmes

Species monitoring programmes in Wallonia focus on seven indicator taxa, i.e. orchids (up to 2001), dragonflies, butterflies, amphibians, reptiles, birds and bats. These taxa are monitored on a periodic basis in order to detect regressions and expansions within distribution areas. Data are recorded by specialised working groups made of volunteers (naturalists, foresters, etc.) and validated by scientists working in universities or within the Research Centre for Nature, Forests and Wood (under the DGRNE), hereafter referred to as RCNFW. Generally, data are recorded on a presence/absence basis in specific sites and refer to 5 km x 5 km UTM plots. They are gathered in a central biological database managed by the RCNFW. From this database, synthesis information is regularly produced as distribution maps, red data lists, ecological preferences and identification of major threats. This information is available through the following website: http://mrw.wallonie.be/dgrne/sibw and will be used in the future to develop species action plans for priority taxa.

These data are complemented by short-term and specific surveys on other taxonomic groups such as flora, grasshoppers, ladybird and carabid beetles, fishes, etc. Biological information is also gathered through other programmes like the survey on biological quality of running waters (see 3.3.), the Permanent Survey of Woody Resources and the Survey of Key Sites for Biodiversity Conservation (SGIB).

More recently, specific monitoring programmes were launched by the RCNFW in close collaboration with universities and research consultancies to follow up population trends of species listed in the Habitats Directive (see annex 3).

4.2. Trends and red data lists

Red data lists have been produced for the different indicator taxa monitored through the regular survey programme. Partial information is also available for other groups such as vascular plants (SAINTENOY-SIMON, in prep.), grasshoppers (DECLEER *et al*. 2002) or ladybird beetles (BAUGNÉE & BRANQUART 2000). The pivotal years used for the analysis of population trends are 1950 and 1990. The former is a turning point corresponding to the intensification of farming and forestry systems as well as to urban development and the expansion of transport infrastructure (see subchapter 2).

Results gathered through the monitoring programmes show that the Walloon flora and fauna undergo a drastic decline in a large number of species, together with the geographic expansion of a very limited number of common and widespread taxa. The table below gives a general overview of the number of species found in Wallonia and is divided into five IUCN categories: extinct, endangered, vulnerable, non-threatened and introduced. According to the taxonomic group, between 40 to 83% of the species display a clear population decrease (mean: 57%). The most threatened taxa are orchids, butterflies, reptiles, amphibians, breeding birds and bats. A more detailed analysis of trends for each biogeographical region shows that the 'brabanço-hennuyer' plateau and the Meuse region are the areas with the most frequent cases of population decreases. Declining species display specific life-history traits. They are often found in a narrow habitat range, for instance semi-natural open habitats (e.g. dry grasslands, heathlands, peatlands) and forest habitats. They are also specialist feeders and poor dispersers, highly susceptible to habitat quality and fragmentation (HALLET 1993).

These data do not give information about how population densities evolve within individual sampling plots (5 km x 5 km UTM plots) and shade population trends of widespread species. The quantitative survey of common bird species performed recently by Aves (VANSTEENWEGEN & JACOB, in press) shows that many species previously considered as unthreatened (no contraction of distribution area) are actually subjected to a marked population decrease. It is the case of several common species living in man-made and agricultural habitats such as the house martin (*Delichon urbica*), meadow pipit (*Anthus trivialis*), skylark (*Alauda arvensis*), tree sparrow (*Passer montanus*) and some bunting species (*Emberiza* spp. & *Miliaria calandra*). So far, the causal factor of their regression remains unclear.

Table 7. Species status for the different taxonomic groups surveyed in Wallonia [after Bournérias 1998 (1), Anonyme 2003 (2) and Goffart & De Bast 2000 (3)].

Taxonomic group	Total number of species	Number of extinct species	Number of endangered species	Number of vulnerable species	Number of introduced species	Proportion of extinct or threatened species	Ref.
Orchids	52	7	19	17	0	83%	1
Dragonflies	66	4	10	17	0	47%	2
Butterflies	114	16	25	39	0	70%	3
Amphibians	17	3	2	4	2	53%	2
Reptiles	9	1	1	3	1	56%	2
Breeding birds	170	9	26	40	7	48%	2
Mammals	69	2	8	18	10	40%	2

Species that extend their geographic range are usually synanthropic and plastic species able to take advantage of human activity. The fox (*Vulpes vulpes*) and black-headed gull (*Larus ridibundus*) are typical examples of this situation. Surprisingly, other expanding species are found among charismatic birds that were previously subjected to population decline. Predatory birds as the great crested grebe (*Podiceps cristatus*), cormorant (*Phalacrocorax carbo*), grey heron (*Ardea cinerea*), black stork (*Ciconia nigra*), sparrowhawk (*Accipiter nisus*), peregrine (*Falco peregrinus*) and eagle owl (*Bubo bubo*) are typical examples of such species with recovering populations. They undoubtedly take advantage of hunting regulation, fish density increase and abandonment of pesticides with a high bio-accumulation potential that were widely used during the sixties and the seventies.

The number of introduced species able to become invasive is rather limited within the investigated taxa. Few species however begin to become abundant and potentially harmful to the environment and indigenous species. Because they already have caused damage abroad, the following species deserve to be carefully monitored and controlled when appropriate: the North American bullfrog (*Rana catesbeiana*), lake frog (*Rana ridibunda*), red-eared terrapin (*Trachemys scripta elegans*), Egyptian goose (*Alopochen aegyptiacus*), Canada goose (*Branta canadensis*), ring-necked parakeet (*Psittacula krameri*), American mink (*Mustela vison*) and muskrat (*Ondatra zibethicus*).

4.3. Major threats

Results presented above show that the future of many species is strongly jeopardised. Some of them have already disappeared from the Walloon territory and many others are on the verge of extinction. Species erosion is the result of three major threats described hereafter (Hallet 1993).

4.3.1. Habitat loss, degradation and fragmentation

The first cause of biodiversity loss in Wallonia is undoubtedly habitat loss, degradation and fragmentation. It is the direct consequence of the high human pressure on the environment: intensification of land use practices, expansion of urban, infrastructure and industrial areas, etc. All the habitat types are currently affected by this process. Most of extensive open habitats have been transformed and reclaimed while remaining ones urgently need to be managed in an appropriate way to limit invasion by scrubs and trees. The intensive use of pesticides and fertilisers, as well as the rarity of hedgerows and refuge areas, is a direct threat to agricultural biodiversity (see 3.1.). Forestry practices underwent major changes during the last century. Many forest species declined as a consequence of both the closure of the forest cover and the scarcity of old-growth forest areas. In woodlands, heliophilous species urgently need to be favoured and regenerated through active management. On the other hand, clumped ageing plots and strict forest reserves have to be created to conserve species linked to veteran trees and high dead wood volumes. Draining, filling, straightening and cleaning-out of waterways are standard practices unfavourable to freshwater and wetland biodiversity. Finally, the increasing pressure of recreation and leisure activities on the natural environment is a direct threat for the remaining natural areas, including waterways, cliffs and underground cavities.

4.3.2. Chemical pollution and global change

Pollution and climate change consist in a second threat to biodiversity that affects various habitats and needs to be added to their physical alteration. Air pollution has direct consequences on forest decline and on the balance of soil nutriments in grassland and meadow ecosystems. For instance, atmospheric nitrogenous supply changes the composition of the flora, favours nitrophilous species and decreases plant diversity. It is also well known that the impact of eutrophication and water pollution on freshwater and wetland biodiversity is very harmful.

On the other hand, climate change is expected to alter the distribution and abundance of organisms throughout the world and to disrupt life-cycle movements and the functioning of communities (ROOT *et al*. 2003). Some cases of climate-induced populations extinctions have been already recorded especially within habitat specialists. Such changes in distribution range are mostly induced by climate warming and increasing stochasticity in meteorological events (WARREN *et al*. 2001, MC LAUGHLIN *et al*. 2002). Recent arrivals of southern species have been recently recorded in Wallonia within several taxa like plants, bees, dragonflies and birds. Though these new species participate to enhance global biodiversity in Wallonia, an extinction of Boreal species found in raised bogs and an alteration of these ecosystems is to be feared in the Ardenne (GOFFART & DE SCHAETZEN 2001).

4.3.3. Invasion by alien species

The problem of the invasion of natural ecosystems by alien species is rather recent, although some species already invaded freshwater ecosystems a long time ago. Up to now, consequences on biodiversity are still limited but this situation may evolve in the following years. New invasive alien species appear each year and the phenomenon deserves to be carefully monitored. Potential damage caused by these species are habitat degradation, transmission of parasites or diseases, species introgression and elimination of native species through competition and predation interactions.

In addition to the species quoted in the subchapter 4.2., the following detrimental invasive species have to be carefully monitored and controlled through adequate measures. They are found among vascular plants (*Elodea* spp., *Fallopia japonica, Impatiens* spp., *Solidago* spp., *Senecio inaequidens*), molluscs (*Dreissena polymorpha*), crustaceans (*Dikerogammarus villosus*, exotic crayfishes) and ladybirds (*Harmonia axyridis*). It has to be noted that these species are especially encountered within aquatic habitats as well as disturbed terrestrial habitats (alluvial sites, fallow lands, road embankments, etc.).

5. Conservation management, a challenging future

The presented data show that Wallonia has a very nice potential for biodiversity thanks to its diverse biogeographical influences and its former traditional management practices. Even though they are threatened by various pressures, interesting plant and animal communities are still present on its territory and include numerous species and habitats from the EU Birds and Habitats Directives.

Strategies, action plans and concrete measures need to be developed in a near future to protect this precious bio-cultural heritage and to mitigate biodiversity loss. Existing and planned actions focussing on biodiversity conservation are shortly described hereafter.

5.1. Existing biodiversity actions and policies

5.1.1. Network of nature and forest reserves

In Wallonia, state and private nature reserves cover about 6,540 and 1,410 ha respectively (data: Nature & Forest Administration). Most of these correspond to semi-natural open habitats and are subjected to clearing, mowing and grazing management. Some 550 ha are also protected through the status of 'forest reserve'. They are designed to protect specific vegetation types but are still subjected to conventional logging. Strict forest reserves do not exist as such. The mean size of nature and forest reserves is quite low (about 60 ha), with the exception of the Hautes-Fagnes nature reserve that forms a complex of heathland and bog landscapes of 4,500 ha. Currently, 41 wetlands and 57 caves of special biological and scientific interests are also officially recognised in Wallonia and gain from specific conservation measures as detailed in their designation act.

5.1.2. Restoration projects

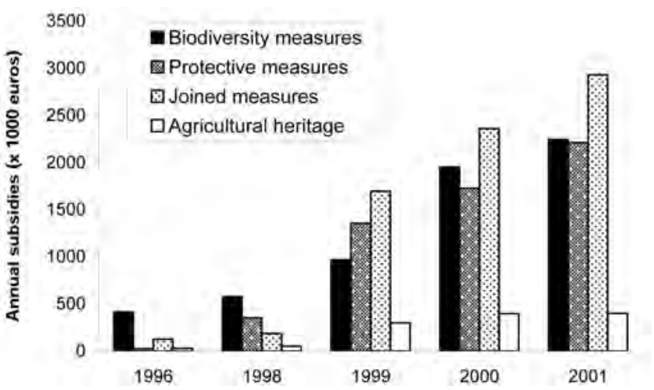
Large-scale restoration projects are currently undertaken by non-governmental organisations (RNOB, Ardenne & Gaume) and the Nature & Forest Administration to restore semi-natural open habitats through EC funding mechanisms (LIFE nature and INTERREG programmes, see table 8). Money is mainly used for land purchase, restoration management and scientific monitoring. Such areas frequently need to be cleared from scrubs and trees before starting standard mowing or grazing management in collaboration with farmers.

Table 8. Examples of restoration projects undertaken in Wallonia thanks to EC funding. Estimated surfaces concerned by the projects: (1) restoration, grazing/mowing management; (2) land purchase and (3) global perimeter of target habitats (total area of nature reserves or of Natura 2000 sites).

	Surface (1)	Surface (2)	Surface (3)	Location	Priority habitat and/or species
Hay meadows					
LIFE94 NAT/B/001516 LIFE97 NAT/B/004796	120 ha 150 ha	130 ha 150 ha	10,000 ha 7,200 ha	Fagne-Famenne Fagne-Famenne	humid and hay meadows (corn crake)
Wetlands					
LIFE99 NAT/B/006285	250 ha	40 ha	600 ha	Semois valley	humid grasslands, marshes and fens
LIFE00 NAT/B/007148	70 ha	60 ha	900 ha	Haine valley	reed beds
LIFE02 NAT/B/008590	unknown	100 ha	2,000 ha	Rulles, Sûre & Our	running waters & wetlands (pearl mussel)
LIFE03 NAT/B/	300 ha	80 ha	10,000 ha	Saint-Hubert	peat-lands
INTERREG EMR.INT2.96.09.3.024	220 ha	-	-	Hertogenwald	humid grasslands and hay meadows
Calcareous habitats					
LIFE00 NAT/B/007168	70 ha	40 ha	500 ha	Lesse & Lomme	dry grasslands, scrubs and woodlands
LIFE02 NAT/B/008593	180 ha	80 ha	2,100 ha	Upper Meuse	dry grasslands, scrubs and woodlands

5.1.3. Agri-environmental schemes

Annual subsidies for agri-environmental practices have steadily been increasing since 1996 and reached about 8 million EURO in 2001 (figure 7). The total amount of money for biodiversity measures (e.g. delayed mowing, orchards, hedgerows and ponds conservation) has been multiplied by 5 from 1996 to 2001. The relative amount of money for these schemes however declined from 70% to 30% of the total budget during the same period, in favour of soil protection and joined measures. Studies performed in other countries already suggest that agri-environmental schemes are not always very cost-efficient from a biodiversity point of view (see e.g. KLEIJN *et al.* 2001). In Wallonia, in absence of a thorough biodiversity monitoring programme and a careful scientific evaluation of these management schemes, it is actually difficult to know if we really succeed in yielding biodiversity benefits for the money spent.



7
Evolution of the total amount of annual agri-environmental subsidies in Wallonia. Global budget is broken down into four categories according to final purposes: biodiversity, soil protection, combination of previous purposes and preservation of agricultural heritage and old varieties (based on WALOT 2002).

5.1.4. Others

Other initiatives contribute to conservation actions in the field. Council plans for nature development and river basin agreements intend to involve rural actors into a participative process designed to enhance or restore biodiversity at a local scale and to enhance public awareness about nature conservation issues. Delayed mowing of road embankments, fitting out of roofs and church tower for bat and owl populations, installation of nesting boxes for raptors and owls, conservation of old fruit tree varieties, hedgerow restoration are other examples of nature-oriented actions subsidised by the Ministry of the Walloon Region (DGRNE).

5.2. Next biodiversity strategies and action plans

5.2.1. Natura 2000 network

The major future challenging issue in the field of nature conservation in Wallonia will be to adequately design management plans for the 217,500 ha of the Natura 2000 network. It includes the definition of clear management goals and prescriptions for the different sites and species. Moreover, restoration actions will have to be developed for huge surfaces in order to improve the global quality of degraded sites. It will enhance the actions started towards LIFE nature and INTERREG projects for the restoration of semi-natural open habitats. Natura 2000 will also be an excellent opportunity to take care about biodiversity conservation issues in woodland ecosystems, that have often been neglected by conservationists up to now.

5.2.2. Nature action plan

The nature action plan aims at developing a long-term strategy for nature conservation in Wallonia. It will integrate biodiversity related issues through existing initiatives and sectoral policies and identify urgent tools to be developed in the future, using the ecological network as a core concept. Priorities for nature conservation will be identified for several habitat types (forest, wetlands, agriculture, urban areas, etc.) and species action plans will be prepared. This plan is currently in preparation.

5.2.3. Forest biodiversity guidelines and strategy

Forest biodiversity guidelines are currently prepared through a participative process between scientists, policy makers and field practitioners under the initiative of the Nature & Forest Administration and the Belgian Forum on Forest Biodiversity. These guidelines aim at developing an ecological network in forest areas and at defining benchmarks for forest management in the different zones of the network.

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